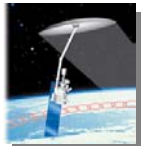


HYDROS: The Hydrosphere State Mission

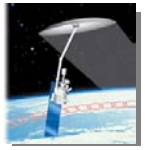
A NASA Earth System Science Pathfinder (ESSP)

PI: Dara Entekhabi (MIT)

Science Return: HYDROS Will Deliver Global Views of Terrestrial Water Cycle State Variable: Soil Moisture Content and Its Freeze/Thaw State

Soil Moisture is a Variable That Links the Global Water, Energy, and Carbon Cycles

MIT JPL NASA Goddard Space Flight Center CSA ASC SPECTRUMASTRO



Science and Application Requirements HYDROS

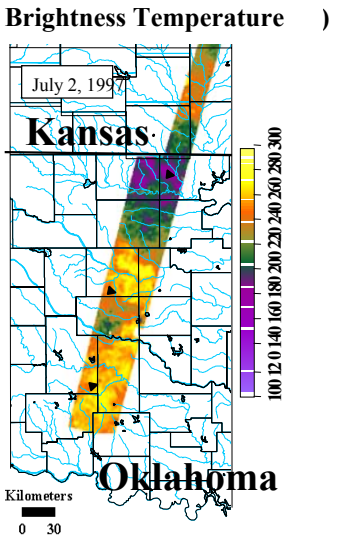
Spatial Resolution:

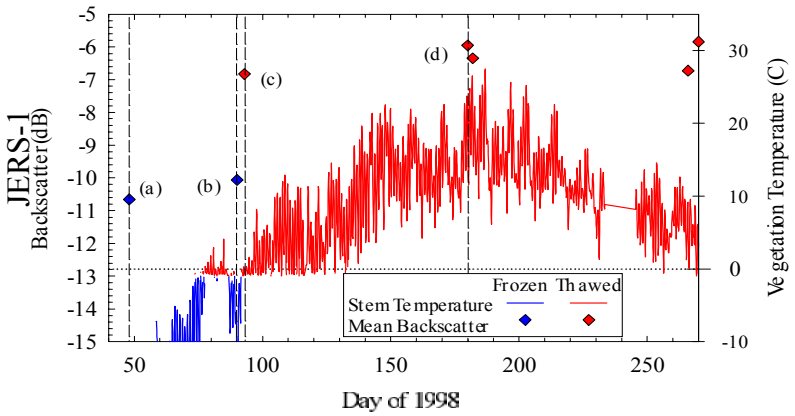
Soil moisture: 40 km (hydroclimatology)
Soil moisture: 10 km (hydrometeorology)
Freeze-thaw: 3 km (heterogeneity)

Temporal Sampling (Global revisit):

2-3 days globally (soil moisture)
1 to 2 days above 45°N (freeze-thaw)

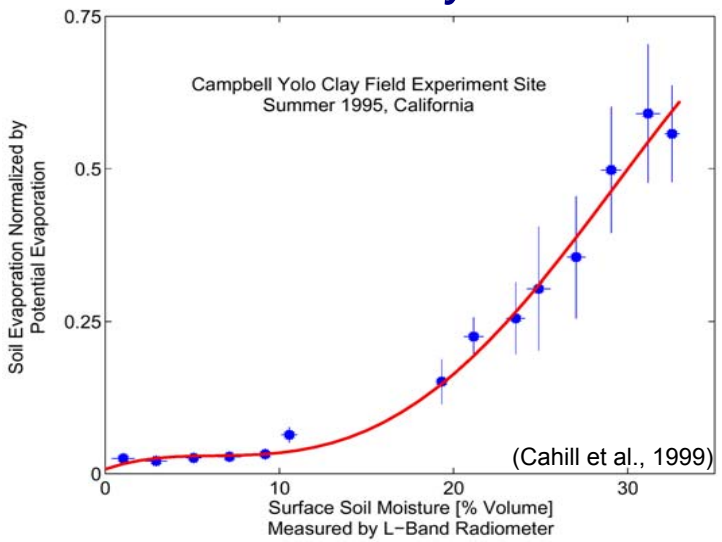
Integrated Active and Passive L-band Sensors



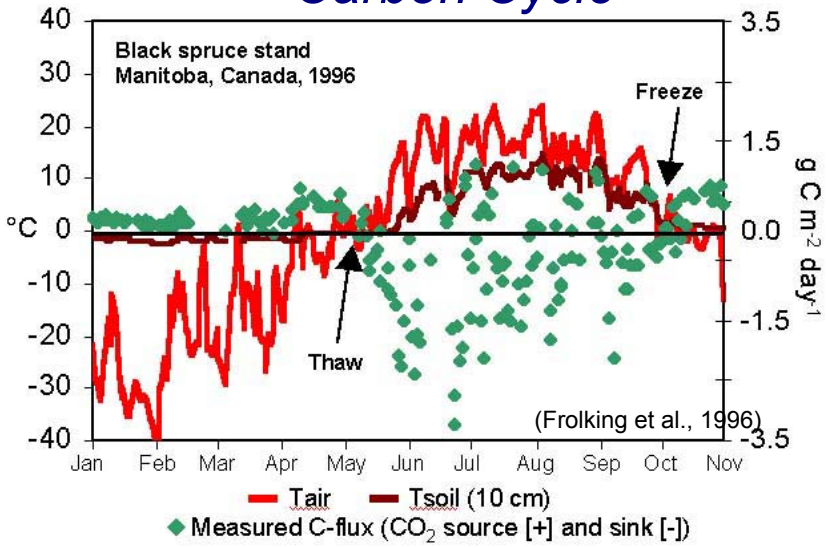


MIT JPL NASA Goddard Space Flight Center

Water Cycle



Carbon Cycle



Soil Moisture Controls the Rate of Continental Water and Energy Cycles

Are climate model simulations of regional hydrology correct?

What is the weather predictability envelope with NWP soil moisture initialization?

Landscape Freeze/Thaw Dynamics Drive Boreal Carbon Balance.

Are Northern Land Masses Sources or Sinks for Atmospheric Carbon?

MIT JPL NASA Goddard Space Flight Center CSA ASC SPECTRUMASTRO

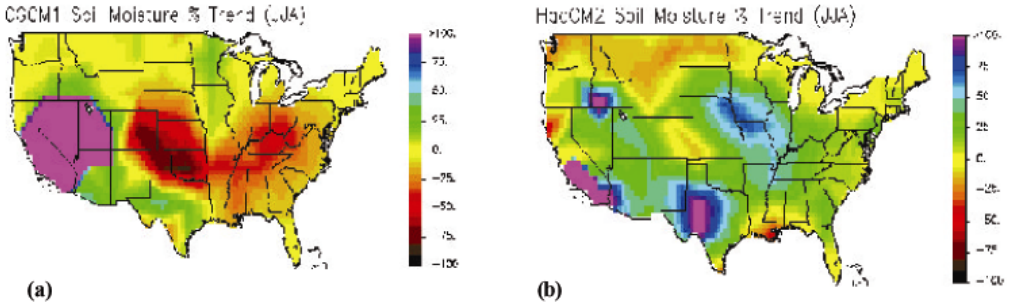
GEWEX WCRP NEWS

World Climate Research Programme

P. Morel in GEWEX News, Feb 2001
Volume 11(1)

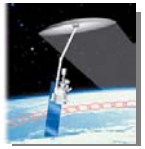
LARGE CLIMATE MODEL DIFFERENCES IN WET PROCESSES

(See article beginning on page 1)



"…models suited for estimating first-order changes in atmospheric temperature profiles…notoriously challenged with regards to reproducing and predicting changes in atmospheric wet processes…"

MIT JPL NASA Goddard Space Flight Center



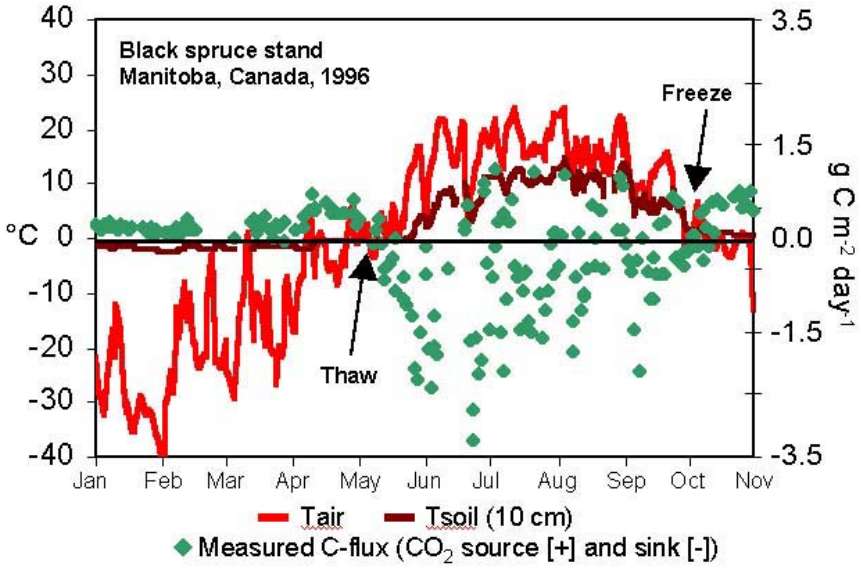
Boreal Freeze/Thaw and 'Missing Sink'

HYDROS

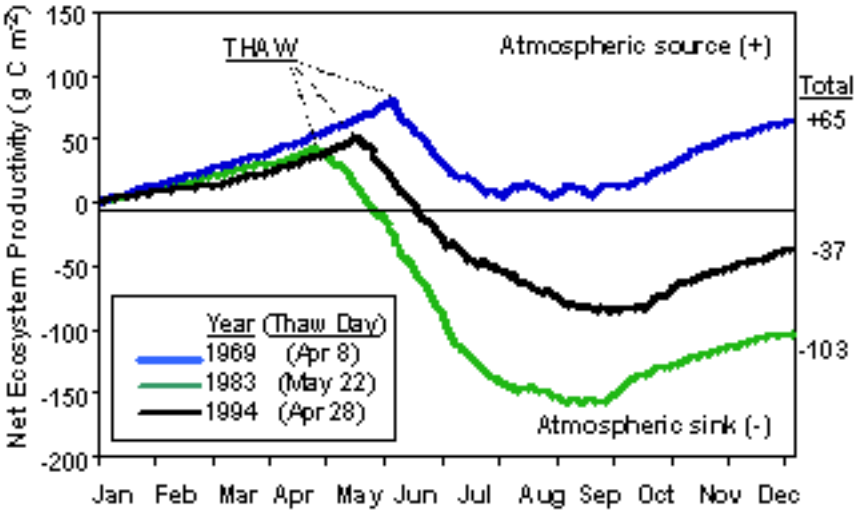
HYDROS provides high-resolution and high-revisit mapping of boreal surface freeze/thaw state that will allow linking:

Freeze/thaw dynamics to variations in environmental factors

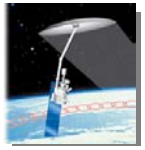
Land freeze/ thaw state to surface resistance to carbon exchange



(Frolking et al., 1996)



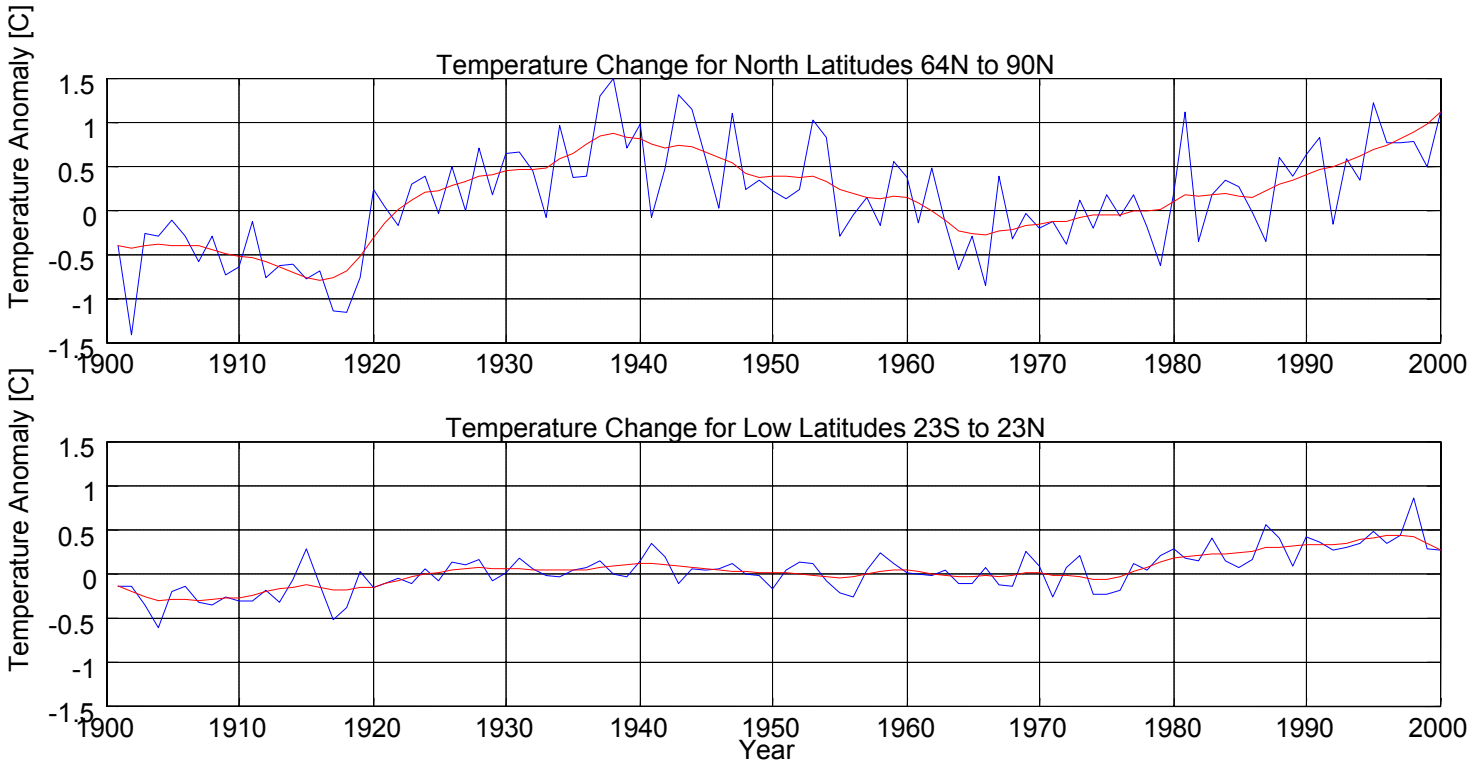
MIT JPL NASA Goddard Space Flight Center CSA ASC SPECTRUMASTRO



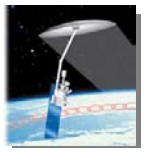
Global Change Magnifying Lens

HYDROS

Knowledge of high-latitudes freeze/thaw patterns is a magnifying lens for identifying the patterns and processes of global change in boreal regions



MIT JPL NASA Goddard Space Flight Center CSA ASC SPECTRUMASTRO



ESE Priorities

HYDROS

HYDROS delivers data products that meet the priority requirements for both science and operational applications.

NASA *ESE Research Strategy 2000-2010* Document

Chapter 4. NASA Earth Science Research Priorities ***Key*** *Observational Requirements Tables*

- **4.1** Earth System Variability and Trends……Soil Moisture
- **4.2** Primary Forcings of the Earth System
- **4.3** Earth System Responses and Feedback Processes……Soil Moisture and Freeze/Thaw
- **4.4** Consequences of Global Changes
- **4.5** Global Change Prediction or Assessments……Soil Moisture and Freeze/Thaw

NPOESS *Integrated Operational Requirements Document (IORD) II*

Soil moisture is a launch-critical Category 1A Environmental Data Record (EDR). DoD-NOAA-NASA Objective EDR is unmet.

+ USGCRP Water Cycle Initiative: *Hornberger 2001 Report*
+ USWRP PDT-9 Hydrologic Aspects of Weather Prediction: *Droegemeier 2000 Report*
+ WCRP/IGBP: *GEWEX/BAHC Leese 2001 Report*

MIT JPL NASA Goddard Space Flight Center CSA ASC SPECTRUMASTRO

L3_3km_F/T

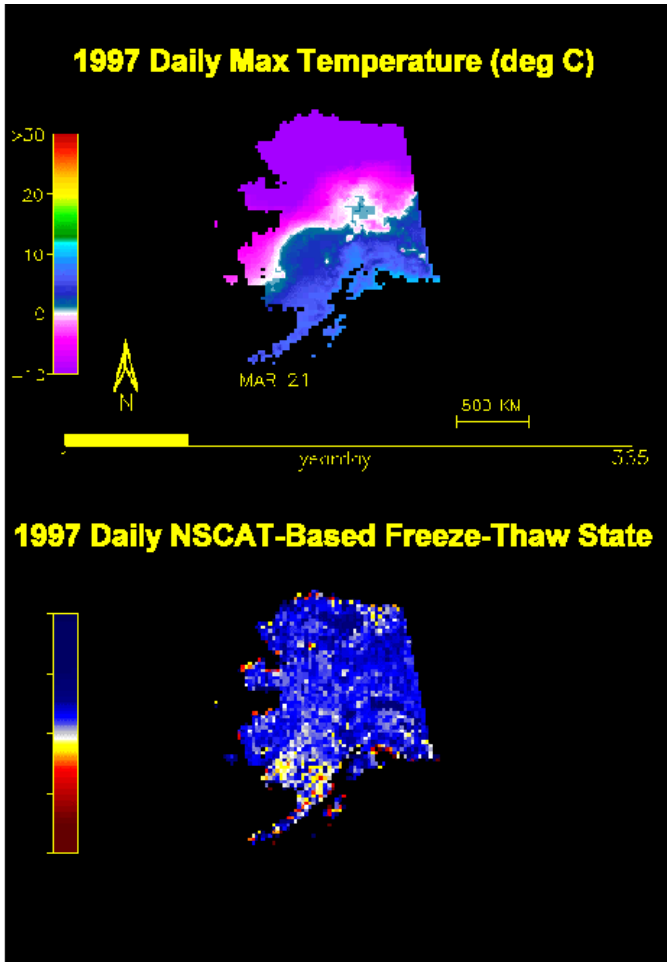
HYDROS: John Kimball (Univ. Montana)

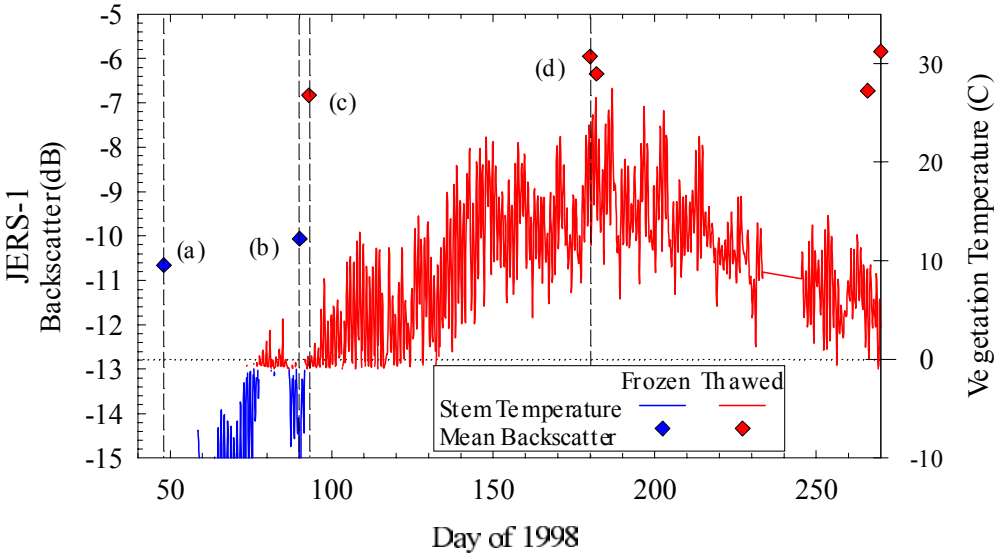
High resolution and high revisit map of boreal surface freeze/thaw state to link the freeze/thaw dynamics to variations in environmental factors

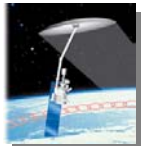
L4_3km_F/T

HYDROS: Steve Running (Univ. Montana)

Link land freeze/ thaw state and surface resistance to carbon exchange







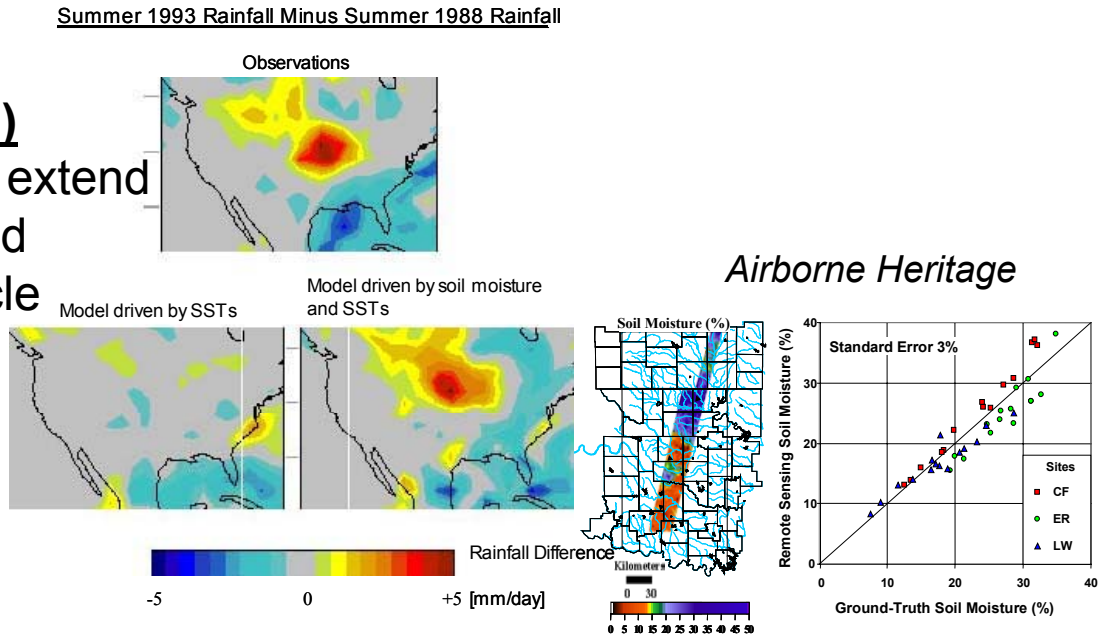
Science Data Products

HYDROS

L3_40km_SM

HYDROS: Peggy O'Neill (GSFC)

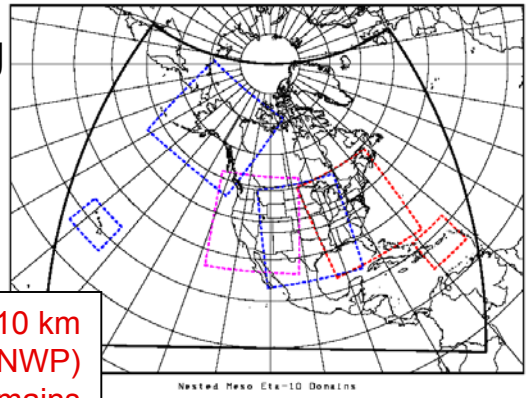
Surface soil moisture mapping to extend seasonal climate predictability and evaluate climate model water cycle processes



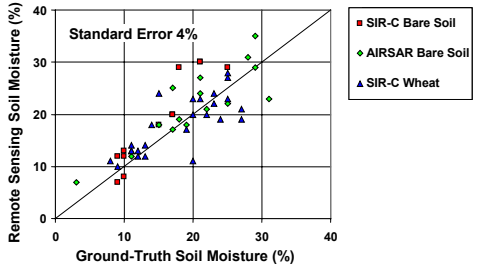
L3_10km_SM

HYDROS: Dara Entekhabi (MIT)

Daily surface soil moisture mapping at higher resolution to initialize NWP and regional atmospheric models.



New NCEP 10 km Numerical Weather Prediction (NWP) Domains

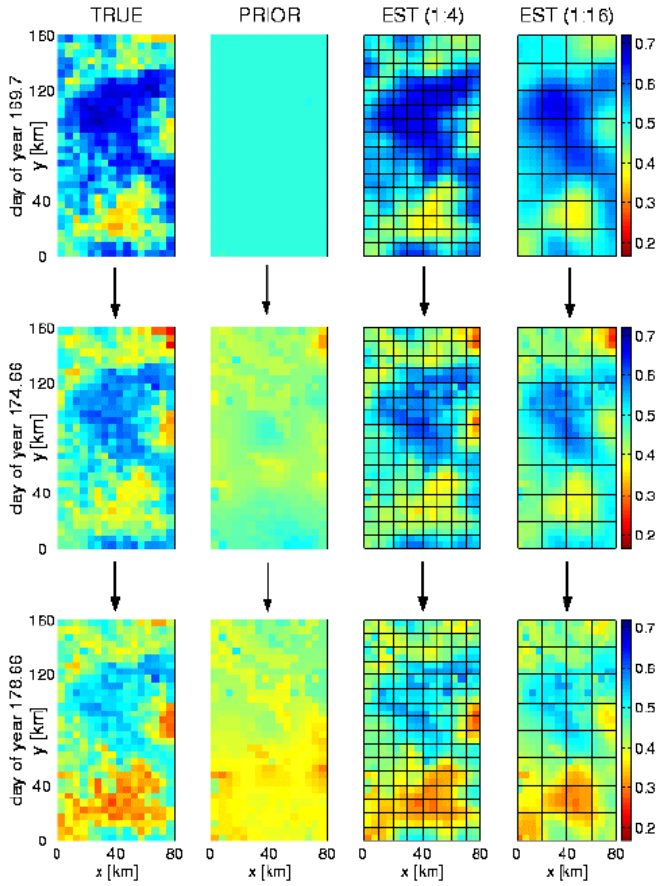


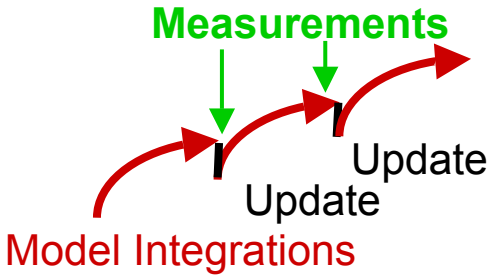
MIT JPL NASA Goddard Space Flight Center CSA ASC SPECTRUMASTRO

L4_5km_4DDA

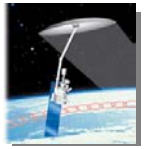
HYDROS: Paul Houser (GSFC)

Merge multi-source and multi-resolution data and models into the most comprehensive ever view of the global land surface conditions.





MIT JPL NASA Goddard Space Flight Center



Summary

HYDROS

1. World-class Science Team made of the leaders in land and ocean microwave remote sensing, field experimentation, and land data assimilation.

2. HYDROS team: Six universities, JPL, GSFC, and industry.

3. Science return is unprecedented: Data products that answer fundamental questions in all major Earth system cycles

4. End-to-end pathfinder science mission:
   - Applications community is demanding the measurements
   - NASA-DoD partner in national security
   - HYDROS science is basis for a unique education activity

MIT JPL NASA Goddard Space Flight Center CSA ASC SPECTRUMASTRO